INSPECTION REPORT

CRYSTAL LAKE DAM
CT DEEP #08301

PROUT HILL ROAD
PROUT BROOK
MIDDLETOWN, CONNECTICUT

PREPARED FOR:

STATE OF CONNECTICUT DEEP

FEBRUARY 2017

Prepared by:

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Connecticut Department of
Energy & Environmental Protection
Bureau of Water Protection & Land Reuse
Inland Water Resources Division

DAM SAFETY PROGRAM
DAM INSPECTION REPORT FORM – FOR REGULATORY INSPECTION

Please complete this form in accordance with the instructions (DEEP-DAM-INST-002).

Part I: Summary of Dam Inspection

Dam Name:	**Crystal Lake Dam**	Inspection Date(s):	**October 18, 2016**
Alternate Dam Name(s):		CT Dam ID #:	**08301**
Location (Municipality):	**Middletown**	Temperature / Weather:	**Sunny, 70ºF**
Registered?: Yes or No If yes, provide the 9 digit registration number found on the notification letter.	**201205008**	Pool Level: See Instructions	**16" above spillway crest (with weir boards in); Elev. 174.50'**
Emergency Action Plan?: Yes or No If Yes, see instructions	**Yes (See Other Information)**	Impoundment Use: use options listed in instructions	**Conservation & Recreation**
Hydraulic and Hydrologic Analysis?: Yes or No If Yes, see instructions	**Yes (See Other Information)**	Stability Analysis?: Yes or No If Yes, see instructions	**Yes (See Other Information)**
Overall Condition: (refer to Appendix A located at the end of this form) **Poor**			

Persons present at the inspection *(select the tab button in the last cell to the right to create another row)*		
Name	**Title/Position**	**Representing**
Karl F. Acimovic, P.E.	**Consulting Engineer**	**Inspector**
Alexander Acimovic	**Engineering Technician**	**Inspector**
Daniel Biron	**Senior Environmental Analyst**	**DEEP**
Charlie	**Groundskeeper**	**Polish Falcons**

Owners and Operators: If there is more than one owner or operator, copy the empty table below for each owner or operator and paste right below the previous table, then complete the information for each

*By providing this e-mail address you are agreeing to receive official correspondence from DEEP, at this electronic address, concerning the subject report. Please remember to check your security settings to be sure you can receive e-mails from "ct.gov" addresses. Also, please notify DEEP if your e-mail address changes by email via deep.damsafety@ct.gov.

Indicate if Owner or Operator: Owner

Name: **State of Connecticut, Department of Energy & Environmental Protection**

Contact: **Daniel Biron, Senior Environmental Analyst**

Mailing Address: **79 Elm Street**

City/Town: **Hartford** State: **CT** Zip Code: **06106**

Phone: **(860) 424-3892** ext.:

Emergency Phone: **(860) 424-3333**

*E-mail: **dan.biron@ct.gov**

Indicate if Owner or Operator: Operator

Name: State of Connecticut, Department of Energy & Environmental Protection

Contact: Deb Corcoran, Operations Supervisor, DEEP Eastern District

Mailing Address: 209 Hebron Road

City/Town: Marlborough **State: CT** **Zip Code: 06447**

Phone: (860) 295-9523 **ext.:**

Emergency Phone: (860) 424-3333

***E-mail:**

Part II: General Dam Information

General Description: The main dam consists of an earth embankment approximately 140 feet long and 50 feet high, originally built where Prout Brook forms a valley between bedrock cliffs on both sides of the brook. The downstream slope is at an approximate 2H : 1V grade and is covered with intermediate sized, ungrouted riprap; the original design plans indicate that a drainage blanket was placed under the stone fill. The crest of the embankment is 20 feet wide, with a 0.5'-0.7' peak in its center, and has a grass cover. The upstream slope is partially grassed, with grouted riprap inlaid and partially covered with soil over most of the slope. Within the main central portion of the embankment there is a core consisting of impervious fill materials, at the base of which an 8-foot deep concrete core wall is cut into the underlying bedrock, and below which there is an additional 8-foot deep grout curtain within the bedrock itself. Midway beneath the downstream slope, and along the base bedrock face, is a series of pressure relief wells set into the underlying bedrock, which wells then discharge to the downstream toe through a stone drainage blanket. There is an intake structure approximately 65 feet upstream of the dam, from which a pipe delivers flow to the base interior of the water control / gate structure situated within the upstream embankment. From this structure, which also acts as a drop inlet spillway, flow then discharges from its downstream base through a 36-inch reinforced concrete pipe, exiting at an outlet structure at the toe of the downstream embankment. Water level for the impoundment is controlled within the water control / gate structure firstly by a spillway cut into its left side, at which water level is set by weir boards, with flow dropping into the structure and exiting via the low level outlet; secondly by interior separators, each consisting of a combination of concrete wall and slots for weir boards, situated at equal interior intervals, having a top elevation 2' below the top of the structure; and thirdly by two sluice gates – one at each interior separator – one of which is typically closed but which, when opened, allows water to flow directly to the low level outlet pipe. To the left of the dam proper is a section of fill, approximately 8' wide, which allows access to small vehicles for basic maintenance of the dam. This section is built out from the bedrock adjacent to the dam, and is faced along the pond by a concrete retaining wall.

Hazard Classification:	**C**	**Dam Height (ft):**	**50 ft.**
Dam Length (ft):	**140 ft.**	**Spillway Length (ft):**	**3.0 ft. (Left Side Drop Inlet) / (3 grated drop inlets at top of structure, each 6' x 3')**
Spillway Type:	**Drop Inlet Weir**	**Normal Freeboard (ft):**	**5.5 ft.**
Drainage Area (square miles):	**0.29 sq. mi.**	**Impoundment Area (at principal spillway crest, in acres):**	**34 acres**
Watercourse(s):	**Prout Brook**		

OTHER INFORMATION:

History – A dam was first constructed at this site in the mid-1800s in order to impound a reservoir of water for use at mills located further downstream and operated by the Russell Manufacturing Co. This company continued to own and operate this dam until it failed catastrophically in April of 1961. The dam was described in historical file information as a 35' high earth embankment with a horizontally curved brownstone masonry wall along its downstream face; a 3' x 2' gated pipe culvert was used to control the pond's water level. Although the precise cause for the failure of the dam was never conclusively determined, records from the 20 years preceding the failure indicated persistent problems with seepage and leakage through the embankment, and recommendations had repeatedly been made by B.H. Palmer of the Board of Supervision of Dams to drain the impoundment and conduct an investigation and repairs. Reports from the time of the failure mention that divers had been attempting to patch the structure in the 2-3 days immediately preceding the failure. Media reports about the aftermath of the breach of the dam noted that there were 3 injuries, washouts of roads and a bridge downstream of the dam, and extensive damage and evacuations from houses in the flood plain. An analysis by John J. Curry, Chief Engineer of the Water Resources Commission, noted the poor foundation construction visible after the breach (which allowed for seepage channels between the bedrock at the base of the dam and the earth placed on top of it) and the possibility that the dam in its final form had been constructed on top of an earlier, lower structure.

Ownership of the dam site was transferred to the State of Connecticut in 1965, and reconstruction of the dam was completed in 1966 (plans and design reports for this reconstruction are on file with the DEEP Dam Safety Section). A repair project was performed in 1990, which consisted of improvements to the main water control structure. These included cutting out the current drop inlet weir on the left side of the structure, installing weir board slots and boards within the new cutout, installing a safety mesh cover over the new opening, and installing a wire basket just inside the new opening to collect trash and debris. These metal fixtures quickly deteriorated and were either missing and / or broken by the late 1990's. In December 2009, the trash rack at the downstream outlet pipe discharge was found to be fully plugged with debris, which had subsequently frozen over with ice and completely blocked flow. As had previously occurred in the winter of 1996, this created an emergency situation, as water levels in the lake were rising toward the top of the embankment. The old trash rack was cut apart and taken off with power equipment and subsequently replaced with a simpler trash rack consisting of rebar (see Photo Report).

Phase I Report – A Phase I reported was completed by Flaherty Giavara Associates, P.C. for the Corps of Engineers in 1980. A copy of this report is on file with the DEEP Dam Safety Section. This report was well prepared and extensive, providing a thorough description of the dam, its condition, and its history. Several of the recommendations made therein, including removal of trees and brush and monitoring of seepage, remain pertinent to this day; others, including a recommendation to remove the cumbersome downstream pipe outlet trash rack to allow a quick release of flow, were prescient. Of note, the report advised the then-DEP to perform full inspections of the dam on an annual basis, due to its hazard classification.

Other Reports & File Information – A Phase II Report was completed by Purcell Associates in 1983; a copy is on file with the DEEP Dam Safety Section. This report recommended repairs to the main water control structure, removal of trees and brush from the dam and from within 25' of its embankments and toe, and regular monitoring of seepage. An Interim Land Record Research Report, detailing the history of ownership of the dam site and of the easements and rights-of-way held by the DEEP over abutting properties, was prepared by this office for the DEEP in 2015.

Hydrologic and Hydraulic Analysis – A hydrologic and hydraulic analysis was prepared as part of the Phase I Report. Because of the dam's hazard rating, the test flood was deemed to be the Probable Maximum Flood (PMF). As such, the hydrologic and hydraulic analysis analyzed three PMF possibilities, a 1-hour, a 6-hour and a 24-hour storm. It was determined that the 6-hour PMF was the most critical of the three potential durations. Calculations then determined that this storm resulted in a maximum water surface elevation of 179.7 feet, allowing for a freeboard of 0.8 feet to the top crest of the dam embankment (at 180.5 ft.). The outflow for this storm event was determined to be 184 cfs, as compared to a total capacity of 196 cfs at full dam height. Although not stated in that report, it is assumed that this capacity would be with full and unobstructed spillway and outflow openings. Therefore, we would temper this capacity with the probability that, based on past observations over the last three decades, there is a high likelihood that some capacity may be lost due to debris covering some of the opening area required for flow.

Stability Analysis – A formal stability analysis was prepared by Professor Karl Hendrickson of the University of Massachusetts during the course of the design work for the reconstruction of the dam in the 1960s, and is included within the Phase I Report. The dam, as then designed and constructed, was calculated to have a Factor of Safety of 2.7 with regard to sliding. Several additional points of analysis and recommendations made by Clarence Welti, P.E., regarding the design are also included therein.

Emergency Plan – An Emergency Operations Plan was prepared by Purcell Associates in 1983, along with an Operations and Maintenance Manual. Although slim, it contains sound directives on the management of the dam during both routine and emergency situations. Because of the age of this plan, it no longer fits the template of requirements recently prepared for new Emergency Plans, and will have to be updated. However, and especially because the DEEP itself is the owner of the dam, the existing plan, if followed, is sufficient to remain in place until recommended improvements and modifications to Crystal Lake Dam are carried out, at which time a new EAP can be tailored to suit the modified structure.

Diving Inspection – A diving inspection was carried out for this dam in 1996, at which time the condition of both intake structures was examined and found to be sound. Divers were again called to the site during the emergency situation in 2009, at which time they examined blockages and cleared the downstream outlet area of debris buildup that had caused the lake level to rise along the upstream embankment.

Photo taken May 3, 1961, looking downstream from within the empty lake toward the breached Crystal Lake Dam. The tree-covered bluffs on either side of the breach present a similar appearance as is present today.

Another photo taken May 3, 1961, this time looking upstream at the area where the dam had previously stood.

HARTFORD TIMES - APRIL 27, 1961

Crystal Lake Leaves Sea of Mud in Wake

By DENNIS RILEY
Times Staff Writer

Middletown — The Crystal Lake Dam burst here before dawn today, sending millions of gallons of water pouring into lowlands over an area of several square miles.

Three persons were slightly injured and 11 homes were damaged.

About 50 persons in 15 families were evacuated from the flooded section after the dam gave way at 2:45 a. m.

Samuel G. Cannon, superintendent of Public Works, estimated damage to houses alone at $100,000.

John C. O'Brien, deputy superintendent of Public Works, set $50,000 as a preliminary estimate of highway damage. Personal property, utility services and farms also were hit.

A bridge over a small brook was washed out.

Mayor Harry T. Clew, later this morning, called on the Federal Housing and Home Finance Agency to declare a flood section here a disaster area. He requested a field representative to come Friday to inspect the damage..

* * *

THE SCENE was described as a "nightmare" in the Millbrook Rd. and Prout Hill Rd. sections.

Some persons were "washed out of their homes" and then hung onto fences until they were rescued, police said.

Police were notified in a phone call from Mrs. Mary V. Gilbert, a resident affected.

Policemen, firemen, Public Works personnel, Red Cross units and utilities employes helped in the rescue.

Chief Michael Milardo of the South Fire District company, said the flood peak came at 3:15 and lasted briefly. By 3:30, he said, water started to recede.

* * *

THE LAKE WAS about a mile long, up to 60 feet deep and 500 feet across at its greatest width.

All that remains are puddles. The lake had been used for swimming and fishing activities in a Falcon Park recreation program.

The dam itself, about 60 feet high and 40 feet wide, was a brownstone arch structure. Skindivers had checked it in recent days.

Spokesmen at the Russell Manufacturing Co. said previous findings were that Winter frost had damaged the dam wall. Russell has water rights to the pond.

Superintendent Cannon said no official finding has been made on the cause of the break.

* * *

TREATED at Middlesex Memorial Hospital for shock, scratches and abrasions were Mrs. Connie Geremia, in her 40s; her daughter Cheryl, 14 and Miss Carol Imme, 40, identified as Mrs. Geremia's sister.

Reported flooded were the houses of Lou Petruzello, George Clegg, Lewis Angi, Albert Geremia, Joseph Ciaburri, Louis Russo, Loy Hoyle, Edward Landell, Thomas Eastwood and Charles Gilbert.

The home of Michael Champey was less seriously damaged, Chief Milardo reported. About six autos were washed away.

The lake, on a hill, was fed from foothills south of Prout Hill Rd., Mr. Cannon said.

When the dam broke the water rushed down and first hit the Landell Poultry Farm. It next struck the Gilbert home, the the others, rushed past the Russell Manufacturing Co. and on into the Connecticut River.

A brook carried the waters harmlessly past a low section of the Russell plant.

CLEANUP CREWS and newsmen poured in as flood waters susbsided.

"Don't bother to wipe your feet," one stoic resident said as a newspaperman entered his home. He found a half-inch of mud covering the entire downstairs, his cellar completely flooded, and six inches of water left in the bottom drawers of furniture and appliances as the water level went down.

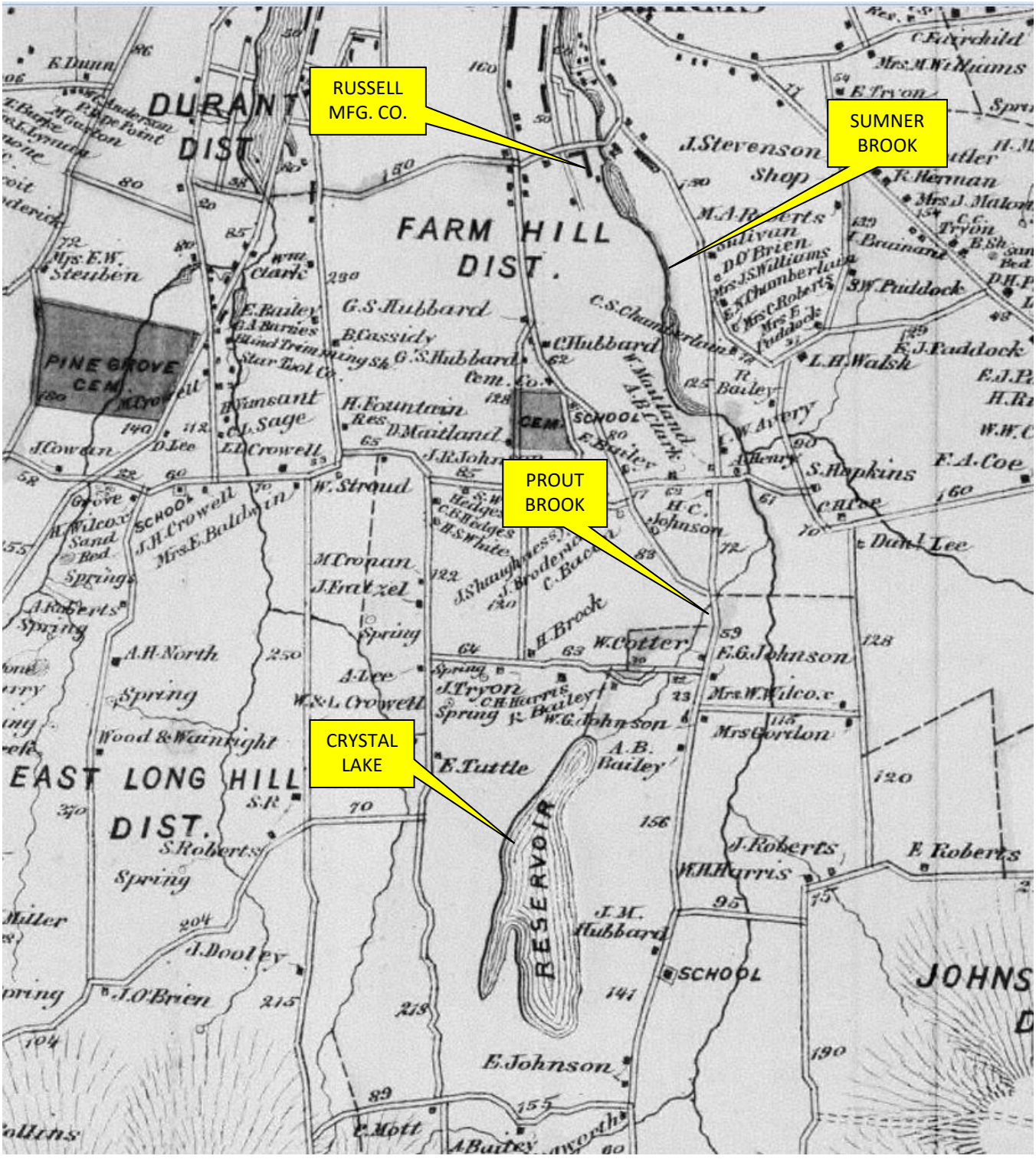
At Crystal Lake this morning, dozens of youngsters scoured the mud flats, once the lake bottom, looking for fish and souvenirs.

Boats left tied last night to shortline docks were hanging, suspended by their mooring lines, over a gaping chasm of mud.

"They knew for years this would happen," one old-timer said. "When my father built his house there in the valley, years ago, they tried to stop him."

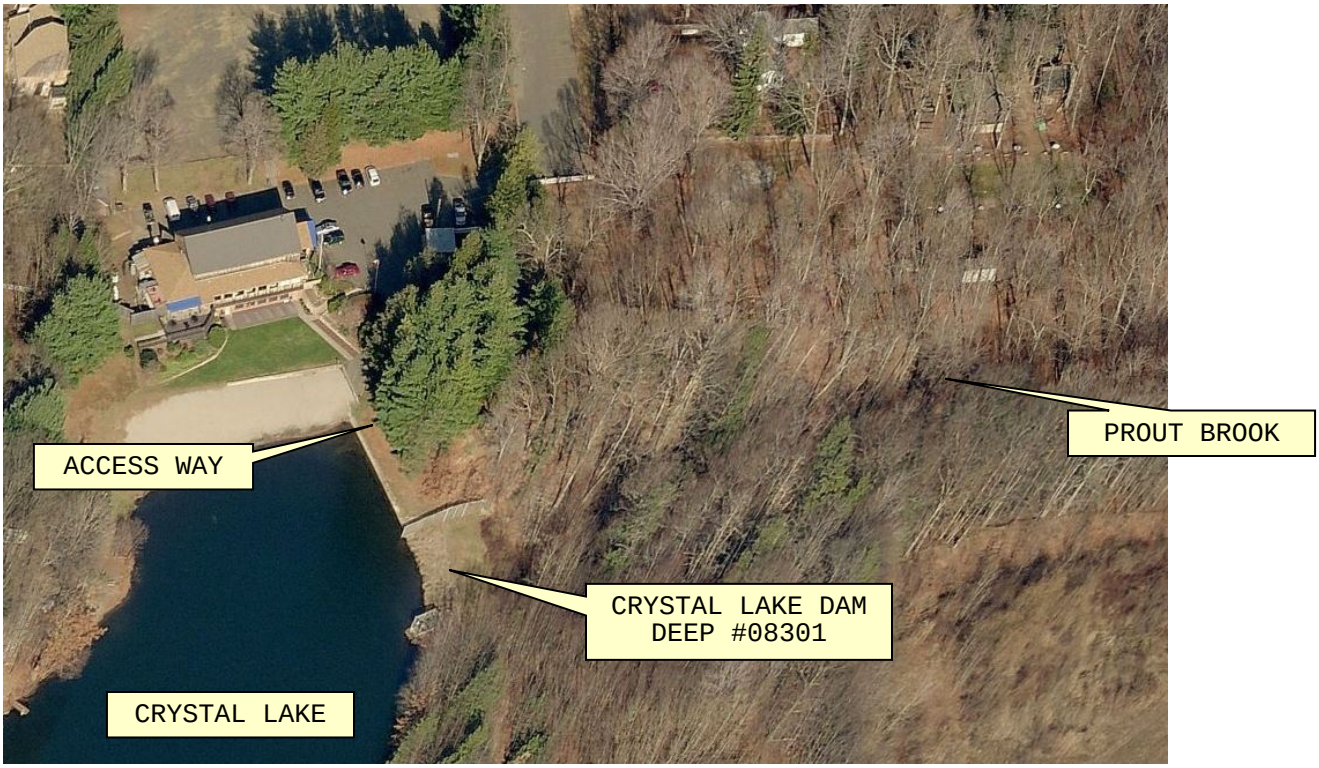
Cleanup crews were plagued by bogged trucks and snarls of tree limbs and rubbish. Police had difficulty routing traffic and curious spectators around the disaster area.

Hartford Times Article on Failure of Crystal Lake Dam *(Source: Phase I Report)*

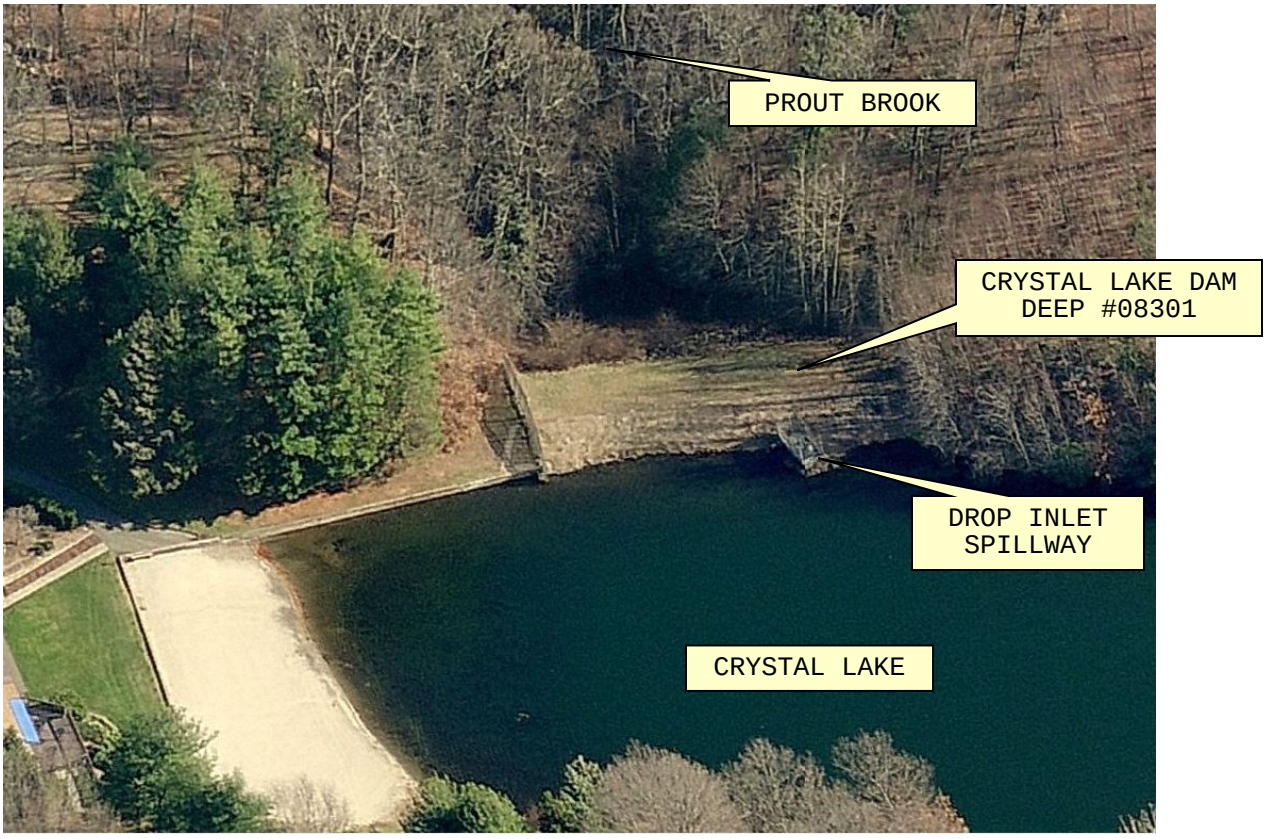


A map from 1868 showing the location of Crystal Lake Dam *(Source: UConn MAGIC Map Archive)*

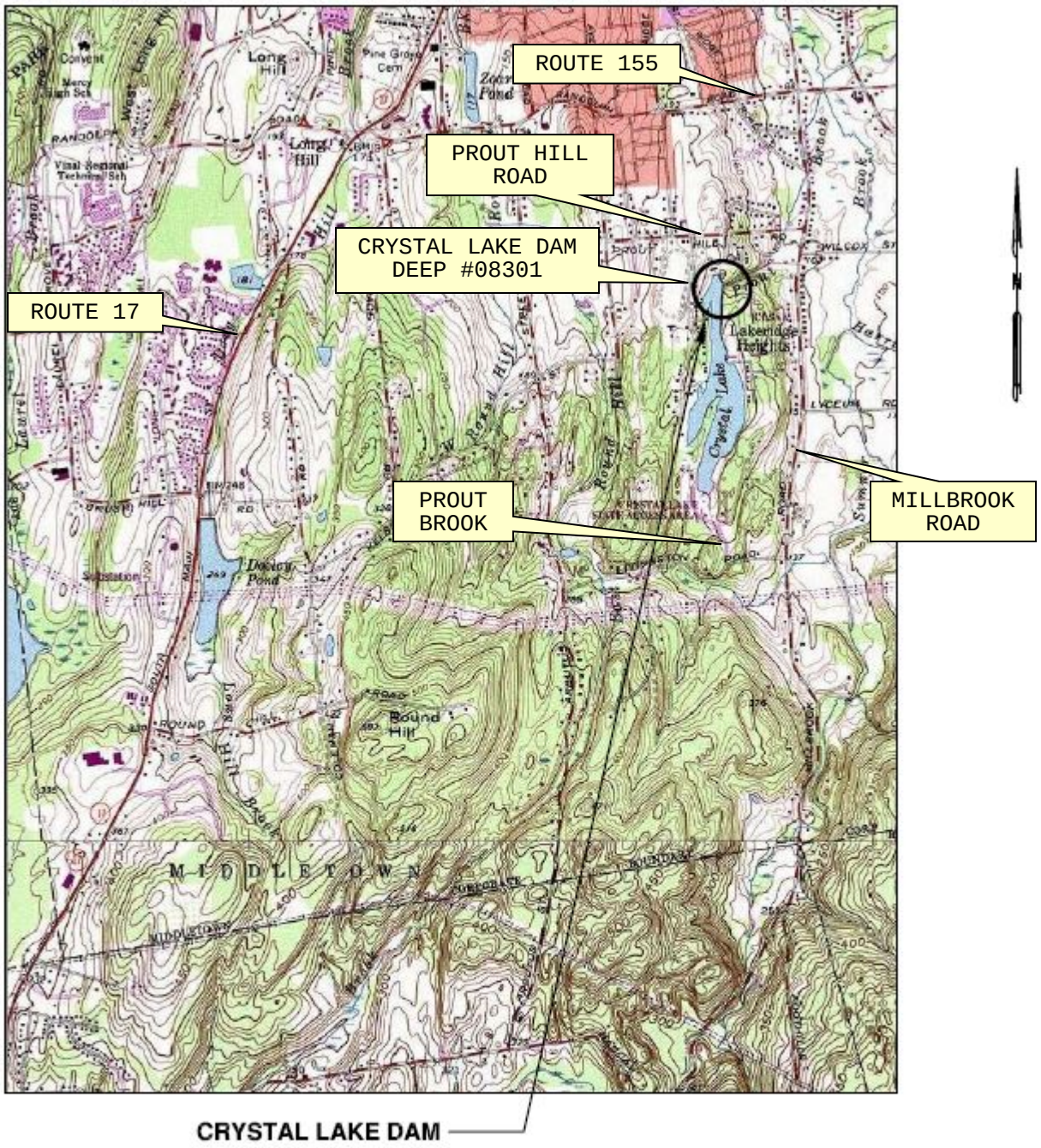
Part III: Aerial Photo/Location Map (insert the aerial photo and location map under this Part. See instructions for details.)



An aerial view of Crystal Lake Dam and its vicinity, looking northward. (*Source: Bing Maps)*



Looking eastward toward Crystal Lake Dam. *(Source: Bing Maps)*



USGS LOCATION MAP

CRYSTAL LAKE DAM
MIDDLETOWN, CONNECTICUT

SOURCE: USGS QUAD SHEET
MIDDLETOWN

CRYSTAL LAKE DAM / LOCATION MAP

Part IV: Dam/Embankment/Dike Information

Number of Dam/Embankments/Dikes: 1

Dam/Embankment/Dike Name: Crystal Lake Dam

General Description: The main dam consists of an earth embankment approximately 140 feet long and 50 feet high, originally built where Prout Brook forms a valley between bedrock cliffs on both sides of the brook. The downstream slope is at an approximate 2H : 1V grade and is covered with intermediate, ungrouted riprap; the original design plans indicate that a drainage blanket was placed under the stone fill. The crest of the embankment is 20 feet wide, with a 0.5'-0.7' peak in its center, and has a grass cover. The upstream slope is partially grassed, with grouted riprap inlaid and partially covered with soil over most of the slope. Within the main central portion of the embankment there is a core consisting of impervious fill materials, at the base of which an 8-foot deep concrete core wall is cut into the underlying bedrock, and below which there is an additional 8-foot deep grout curtain within the bedrock itself. Midway beneath the downstream slope, and along the base bedrock face, is a series of pressure relief wells set into the underlying bedrock, which wells then discharge to the downstream toe through a stone drainage blanket. There is an intake structure approximately 65 feet upstream of the dam, from which a pipe delivers flow to the base interior of the water control / gate structure situated within the upstream embankment. From this structure, which also acts as a drop inlet spillway, flow then discharges from its downstream base through a 36-inch reinforced concrete pipe, exiting at an outlet structure at the toe of the downstream embankment. Water level for the impoundment is controlled within the water control / gate structure firstly by a spillway cut into its left side, at which water level is set by weir boards, with flow dropping into the structure and exiting via the low level outlet; secondly by interior separators, each consisting of a combination of concrete wall and slots for weir boards, situated at equal interior intervals, having a top elevation 2' below the top of the structure; and thirdly by two sluice gates – one at each interior separator – one of which is typically closed but which, when opened, allows water to flow directly to the low level outlet pipe. To the left of the dam proper is a section of fill, approximately 8' wide, which allows access to small vehicles for basic maintenance of the dam. This section is built out from the bedrock adjacent to the dam, and is faced along the pond by a concrete retaining wall.

General Condition: The downstream slope is in poor condition. It is not currently showing signs of instability, but is entirely covered by small trees, brush and woody vegetation growing adjacent to and up through the ungrouted riprap. The density of the vegetation is such that walking down the slope during the peak growth season would be difficult. The crest and upstream slope are in generally good condition, with grass maintained and only minor maintenance issues present.

Concrete Condition: There is a small wall section along the upstream dam crest, the top of which is at ground level, marking or delineating the upper edge of the grouted riprap; although somewhat worn, it is generally in good condition.

Stone Masonry: Not applicable

Settlement/Alignment/Movement: No misalignment or movement issues were noted. There was some minor settlement of surface stones at the base of the downstream toe.

Seepage/Foundation Drainage: No seepage was observed emanating from the downstream embankment. It should be noted, however, that this inspection was completed during an unusually severe dry period. The streambed just below the outlet structure was wet with standing water, which may be attributed to, in part, minor seepage emanating from the low level outlet pipe, drainage from the underlying stone drainage blanket and, potentially, flow through adjacent and underlying bedrock. There was, however, no appreciable flow associated with this wet area below the structure.

Concerns with seepage were noted and discussed extensively in both the Phase I and Phase II reports, and the failure of the original dam at this site was generally attributed to extensive and unchecked seepage. For this

reason, it will be important to maintain a cleared area at this location for future monitoring.

Riprap: The downstream face of the embankment is covered with ungrouted riprap stone, generally intermediate in size. While the stones themselves are generally in good condition, and in place (only a few, scattered stones had rolled down to the toe of the slope), the extent of brush growing through and between the stones is extensive. In addition, as will be noted in the Photo Report, there were several large tree trunks lying across the base area of the downstream slope, apparently from the widespread growth of large and unstable trees growing on and near the edge of the steep inclines directly adjacent to the dam and downstream channel. On the upstream face of the dam, the grouted riprap is mainly standard size and set directly into the earth embankment, rather than laid over the top of it. Areas between the stones were free of vegetative growth, apart from grass.

Erosion/Burrows: No erosion of the embankment material was noted. There were several small animal burrows noted on the right side crest of the dam. These should be filled in and then monitored during routine inspections.

Vegetative Cover: As noted above, the vegetative cover on the downstream slope consists of weeds, brush, woody vegetation and small trees, covering almost the entire embankment. During the growing season, this vegetation can easily reach 6 to 8 feet in height, and the extent of the growth prevents observation of the underlying embankment condition from the crest or toe areas, except that portions can be seen during the non-growing season from the toe. This vegetation has been cut inconsistently in the past, and is difficult to maintain as cutting (even prior to growth of trees and woody vegetation) must be done with hand-held equipment. The grass cover on the crest of the dam is regularly maintained and generally in good condition. The grass areas of the upstream slope are, likewise, in generally good condition, with the riprap set at or near ground level, so that grass between the stones can be more easily maintained.

Other: There are 3 piezometers located on the crest of the dam; one on the upstream side and two on the downstream side. The latter two were obscured by brush at the time of the inspection. The visible piezometer is in fair condition, as the exposed section is substantially corroded.

Photos/Graphics/Sketches: See Photo Report in Section XIII.

Part V: Principal Spillway, Training Walls, Apron

Number of Principal Spillways: 1

Spillway Type: Concrete drop inlet weir.

General Description: The water control structure includes all spillway functions. The “primary” spillway within this structure is a drop inlet weir opening on the left side. It is 3 feet wide and is controlled by the insertion of weir boards. Because of its small size, flows exceeding its capacity must enter from the top of the structure. At the top, there are three grated openings, each 6 feet by 3 feet in size. The three openings are in a line perpendicular to the dam embankment. The opening furthest downstream (or closest to the embankment) is uncontrolled, drops to the interior base and then flows directly out the low level outlet pipe. The second, or intermediate opening, and the third and most upstream opening, drop into boxed chambers controlled by both sluice gates and weir boards.

General Condition: Fair. There is brush growing in front of and near the spillway opening, which must be cut before it matures further.

Concrete Condition: The concrete at the left side spillway opening is in fair condition, with several chipped and spalled sections. On the interior part of the right side wall opening, the wall had chipped away to the extent that rebar was exposed (and had begun to corrode). The concrete and rebar issues may be related to the cut into this existing concrete wall section to create a new opening as shown on the as-built plans of 1990.

Stone Masonry: Not applicable

Settlement/Alignment/Movement: None observed.

Cracks: No significant cracks were noted in this area.

Scouring/Undermining: Only the above-water portions of the structure were observed during this inspection.

Seepage/Foundation Drainage: Only the above-water portions of the structure were observed during this inspection.

Other: The water level of the lake is controlled by the weir boards set along the face of the spillway opening, and notched in by steel pieces bolted to the concrete to create a channel. The top-most, exposed board is heavily weathered, and the boards appear to have been in their current position for an extended time period. The steel channel pieces are corroding.

Photos/Graphics/Sketches: See Photo Report in Section XIII.

Part VI: Auxiliary Spillway, Training Walls, Apron

Number of Auxiliary Spillways: 0

Auxiliary Spillway Type: Not applicable. There is no separate auxiliary or emergency spillway at this site.

General Description:
General Condition:
Concrete Condition:
Stone Masonry:
Settlement/Alignment/Movement:
Cracks:
Scouring/Undermining:
Vegetative Cover:
Riprap:
Seepage/Foundation Drainage:
Other:
Photos/Graphics/Sketches:

Part VII: Downstream Channel

Number of Downstream Channels: 1

Watercourse Name: Prout Brook

General Description: The channel is approximately 8'-10' wide and consists of natural materials, loose stones and exposed bedrock.

General Condition: Fair, based on the trees and brush growing on the sides of, and in some cases in, the stream. There is also significant debris (garbage, along with trees and tree branches) in the area immediately downstream of the outlet pipe discharge.

Scouring: None observed.

Debris: There is debris in and on the banks of the brook; most of this is vegetative debris from fallen trees and branches; there is also some garbage.

Riprap: Not applicable; there is no riprap in the brook channel other than a small number of scattered stones which have rolled down off the downstream embankment.

Other:

Photos/Graphics/Sketches: See Photo Report in Section XIII.

Part VIII: Intake Structure(s)

Number of Intake Structures: 2

Intake Structure Type: Water Control Structure – Concrete box structure; this is the downstream-most of the two intake structures, and serves as the main water control structure.

General Description: A concrete structure, 16' long x 8' wide, with a top elevation of 177.67' and a base (at top of footing) elevation of 147.0'. There are three chambers within the structure, separated by two interior concrete walls. The tops of the interior walls are at elevation 175.0'; the downstream interior wall has slots for stop-logs to be inserted. There are three open steel grates covering the top of the structure and set flush with the top of the concrete; these are designed to act as auxiliary overflow inlets by allowing water to pass through and into the structure in the event of high flows. There are two sluice gates, set flush with the upstream face of each of the two interior walls; the gate operators are set on top of the structure. These gates are normally closed; if opened, they will allow flow from the upstream intake structure to pass directly through to the low level outlet pipe. The drop inlet primary spillway previously noted in Part V is situated on the left side of the structure and drops into the most downstream of the three chambers.

General Condition: Fair. Many of the structure's constituent parts are worn or deteriorated. The stop-logs set in the interior that were visible above water were disintegrating and in a deteriorated state. The condition of the sluice gates and stems could not be ascertained, but were known to have been operated in the past; the gate operators appeared to be in good condition, but should be operated in the near future (see Recommendations, below). The steel grates are in fair to good condition – the grates themselves are generally in good shape, but the bolts attaching them to the concrete are corroded. The gate operating or hoisting mechanisms are in a similar state, with corrosion noted on bolts and covers, but the main functional parts of the mechanisms are, however, in generally good condition.

Concrete Condition: The visible above-ground portions of the concrete walls are weathered, but in otherwise sound condition; minor chipping and spalling was noted. The interior, as such was visible from the top of the structure, appeared in similar condition.

Stone Masonry: Not applicable.

Settlement/Alignment/Movement: None observed. Only the above-water portion of the structure was inspected.

Cracks: Although there is weathering and minor deterioration on parts of the concrete structure, no major cracks were noted.

Other: There are 4 sets of steel ladder rungs leading down from the top of the structure to the interior base; the portions that were visible on the date of inspection appeared to be corroded, and untrustworthy for use.

Photos/Graphics/Sketches: See Photo Report in Section XIII.

Intake Structure Type: Pond Inlet – Low level concrete intake structure, containing the inlet of the 36" concrete low level outlet pipe, and located within the pond 65' upstream of the larger, taller structure described immediately above.

General Description: A 7' long x 8' wide concrete intake structure, with a trash rack covering the top portion of the structure, and the upstream end of the 36" low level outlet pipe set within it. The original construction plans show an invert of 150.0' at the end of the pipe (approximately 24.5 feet below normal water surface elevation), and a total height for the structure, from top of footing to top of walls, as 9'.

General Condition: The structure is submerged, and was not examined during this inspection.

Concrete Condition: The concrete of this structure was inspected by a diver in May of 1996 and found to be in good condition at that time.

Stone Masonry: Not applicable

Settlement/Alignment/Movement: None observed by the diver during the 1996 inspection.

Cracks: None observed by the diver during the 1996 inspection.

Photos/Graphics/Sketches: None available for the submerged structure

Part IX: Outlet Structure(s)

Number of Outlet Structures: 1

Outlet Structure Type (see instructions): Concrete headwall with discharge opening for the low-level outlet pipe.

General Description: A 1' thick concrete endwall, with two supporting concrete wing walls extending diagonally outward and downstream. The 36" RCP outlet pipe ends flush with the endwall; its opening is covered by a rebar trash rack.

General Condition: Fair. The condition of the walls is currently stable, but shows signs of minor spalling along the top.

Concrete Condition: While presently stable, the concrete wall sections have minor chipping and spalling over a portion of the top and upper sections.

Stone Masonry: Not applicable.

Settlement/Alignment/Movement: None observed.

Scouring/Undermining: None observed.

Other: As described in the history section, above, the original steel trash rack covering the pipe outlet became clogged by a combination of ice and debris in December of 2009, and was replaced by a new, much simpler rebar grid bolted directly to the concrete. This rack is in good condition.

The 36" RCP outlet pipe, to the extent that it can be seen from its downstream outlet, appears to be in sound condition.

Photos/Graphics/Sketches: See Photo Report in Section XIII.

Part X: Miscellaneous Features

Miscellaneous Features:

Access – The DEEP-owned property on which the dam is situated is land-locked. Access to the site is through the abutting Polish Falcons property, over which the DEEP holds a right-of-way. This right-of-way, further detailed within the 2015 Interim Land Record Research Report, grants the DEEP extensive rights to access the site for the purpose of maintaining the dam. Direct access to the dam is over an 8' wide strip of grassed fill to the north (left side) of the dam embankment; this area is supported by a concrete block retaining wall running along the lake. The grassed area is well-maintained, but the wall is in fair condition, with some slight displacement of blocks, and deterioration in the form of cracking, spalling and chipped off portions of blocks.

Because this access way is too small to allow heavy construction equipment to reach the dam, alternative routes were sought at the direction of the DEEP in 2015. This included finding a route of access from the downstream side. Although negotiations with neighboring or abutting properties have not been conclusive to date, a potential alternative was noted during the course of this inspection on the Polish Falcons property. The path of this alternative route is highlighted in the Sketches section, below.

Boat Launch – There is a no public-access boat launch area at the site of the dam. There is a state-owned boat launch area located on the upper part of the lake, and also several properties (including that of the Polish Falcons) which abut the lake and from whence boats appear to be launched.

Bridge – There are no pedestrian or maintenance bridges at the dam.

Dry Hydrant – There is no dry hydrant at this site.

Safety – There are chain-link fences running across both the left and right abutments to prevent unauthorized access to the dam. The fence on the right side is in good condition. The one on the left side is in fair to good condition, and has vines and brush growing up extensively on it. This section of fence has a double-wide vehicular access gate where it crosses the dam crest; the gate is in operable condition, but the lock perennially corrodes. The main intake structure is also topped by chain-link fencing; a lattice wooden grating has been attached against the fence on its northern and eastern sides, whereat the fence is also topped with barbed wire. This fence is in fair to poor condition, and is essentially corroding in place, especially the posts and rails. There is a wooden 'No Trespassing' sign affixed to the southwest side of the fencing, facing the lake to warn boaters of the intake structure; however, the sign is now deteriorated and unreadable.

Photos/Graphics/Sketches: See Photo Report in Section XIII.

Part XI: Downstream Hazard Classification Reassessment

Downstream Hazard Classification:

The dam is currently rated as a “C” hazard dam and, based on a visual inspection of the dam and of available data with respect to downstream roads and structures, it is recommended that the rating remain as is.

Part XII: Recommendations *(See instructions for identifying recommendations)*

Recommendations: *(Each item should be numbered)*

1. **Improvements & Repairs** - As previously discussed with DEEP personnel, we continue to recommend that major improvement work be performed on Crystal Lake Dam to put the structure in a better long-term condition for stability and ease of maintenance. Specifically, the most recent draft plans prepared by our office included extending the downstream embankment to a 3H : 1V grade, raising the embankment crest to a top elevation of 181.0', extending the low level outlet pipe to the toe of the extended embankment and replacing the outlet headwall, and modifying the top grating and interior features of the water control structure, as further described below. If completed, these modifications will allow the downstream embankment to be maintained with a riding slope mower, will improve the stability of the dam, provide additional inflow capability during storm events and thereby the freeboard to allow the dam to pass both the 100 year and ½ PMF storm flows, and make the spillway easier to access and maintain.

There is no apparent operational procedure on file for the water control structure. Until such time as this dam is reconstructed or otherwise modified, a working procedure must be set up explaining the reasoning, methodology and timing for operating the two weir board slots and the two sluice gates within the water control structure and the small weir board opening on the left vertical side acting as the primary spillway inlet. It is apparent from this inspection that gates are not operated on a regular basis, weir boards are not set, removed or otherwise controlled on a regular basis, and that boards are so old that they are decaying in place and falling into the base of the structure. Given this situation and lack of maintenance, it is highly probable that boards, along with general debris coming in from the lake, will block flow in most emergency situations. For the foreseeable future, therefore, it is recommended that all old weir boards be removed from the interior of the structure, that the surface grating be removed from the two downstream openings, and that the downstream sluice gate be set into the fully open position so that flow will not be impeded during severe storms. The upstream sluice gate would then be left in a normally closed position unless it is being used for annual or maintenance drawdowns and the upstream grating would also be left in place to provide a support position for the operation of the gate. Consideration should also be given to replacement of interior ladder rungs, which show signs of corrosion and appear unsafe, with either newly installed plastic coated rungs or stainless steel ladders attached to wall interiors.

As discussed more extensively earlier in the report, the previous structure at this site failed catastrophically in 1961 and thereby caused injuries to homeowners and extensive damage to downstream houses and public infrastructure. The downstream and flood-prone areas have changed little in the intervening time, and so the danger of similar consequences if the dam is not regularly maintained exists to this day.

2. **Trees, Brush and Vegetative Cover on and near the Embankment** – Clear and remove all trees and brush from all embankment and abutment areas and within 25' of all toe and abutment sections of the dam. In particular, the downstream embankment needs to be cleared of trees and brush, and maintained by cutting vegetative growth semi-annually, at a minimum. This has been, and as long as there exists an earth embankment dam, will continue to be an item of required maintenance. The perennial nature of this problem is demonstrated by the photographs and recommendations contained in the 1980 Phase I Report, which included the same recommendation for trees and brush to be cut from the dam and all areas within 25' of its embankments and toe, as well as from the outlet channel within 100' of the downstream toe.

Removal of vegetation must also include clearing of the chain link fence surrounding the water control structure and then maintaining it as such in order to provide for the maximum inlet flow during a storm situation without being blocked by growth and debris.

3. **Fencing** – The chain link fencing should, in general, be repaired and / or replaced in all locations at this site. In addition, locks and gates must be kept in good working condition, wood lattice work near the water control structure should be removed, and lattice strips from within the chain link fencing along the left abutment should be removed or replaced. It is thought that lattice work in the fencing, as well as the wood portion near the intake structure, may have been placed to hide a view of the dam. For security, however, it

may be more prudent to allow full visibility for this area.

4. **Gate & Water Control Operation** – The two existing sluice gates should be operated in the near future to ensure that they remain in viable working condition in case of an emergency situation that requires their use. Additionally, the interior of the structure should be cleaned of debris, following which a new and thorough interior inspection of all three chambers should be performed.

5. **Diving Inspection** – Assuming that the improvements noted in Recommendation No. 1 are undertaken, a diving inspection should be conducted prior to the finalization of proposed design work and submittal of permit applications in order to more precisely ascertain the interior and exterior condition of the water control structure, especially its underwater portions, and to once again examine the condition of the submerged upstream intake structure.

Part XIII: Photographs/Graphics

Note: Several photos within this report may be duplicates. This is made necessary by the general requirement of the new DEEP / Dam Safety inspection format which requires specific numbered views for certain portions of the dam. Hence, photos which depict more than one required feature will sometimes be shown more than once to satisfy these requirements. The numbering sequence of the photos follows that of the DEEP form.

Photo 1a – An overview of Crystal Lake Dam, as seen from near the northwest corner of the impoundment.

Photo 1b – An upstream view of the dam proper, taken from the same perspective as the prior photo.

Photo 2a – An overview of the dam taken on October 18, 2016 from the downstream toe area, just beyond the low level outlet discharge.

Photo 2b – Taken in December 2009, this photo shows an overview of the downstream embankment with brush and vegetation cleared.

Photo 3a – The left and center areas of the upstream embankment as seen from the right side abutment.

Photo 3b – A view looking southward toward the right side crest, upstream embankment and abutment area. The water control structure with primary spillway is seen on the far right edge of the photo.

Photo 4a – An overview of the upstream embankment, taken from the left side of the dam. One of the three original piezometers can be seen in the upper left of the photo.

Photo 4b – The left upstream abutment of the dam, located where the chain-link fencing (faced with wooden lattice panels) runs across the embankment. Brush and vines have been allowed to grow unchecked along the fence. The open area in the fence near the center-left of the photo is an access gate. The area in the foreground is the right end of the access way leading to the dam from the Polish Falcons parking lot.

Photo 5 – The crest of the dam as seen from the right abutment area.

Photo 6 – The crest of the dam as seen from the left side abutment area. A piezometer is again partially visible in the center of the photo.

Photo 7a – Although badly obscured by tree and brush growth, this view is of the right side of the downstream embankment, as seen from the crest of the dam. The edge of the embankment is approximately where the large bedrock stone juts out in the right side of the photo.

Photo 7b – A view of the downstream embankment from the same right side crest area as in the prior photo (note the bedrock jutting out on the right of the photo for reference). This photo, taken in March 1996, shows the embankment with brush and vegetative growth cleared.

Photo 8 – No view of the downstream embankment was available from the left side of the dam, due to the height and extent of vegetative growth in that area, immediately downstream of the dam crest.

Photo 9a – Looking southward at the entrance to the drop inlet weir. Brush and vine growth is clearly visible. The arrow points to the inlet; weir boards were in place on the date of inspection.

Photo 9b – A view of the spillway inlet area, with brush and vegetative growth cleared and weir boards in place, taken in March 1996. Note the corrosion on the steel frame channels, which had been installed only six years earlier.

Photo 10 – Not applicable at this site. The spillway is a drop inlet weir set on the left side chamber of the water control structure.

Photo 11 – Not applicable at this site. There is no structural wall along the right side of the dam.

Photo 12 – Looking eastward at the retaining wall running along the access way to the dam from the Polish Falcons parking area and driveway. This wall ends at its junction with the left abutment of the dam.

Photo 13 – A close up view of the spillway weir inlet, with the top weir board visible across the center of the photo.

Photo 14 – The downstream outlet headwall and its adjacent stilling basin at the bottom of the photo. Riprap is still in place here, but there is a visible buildup of brush debris within the basin.

Photo 15 – Taken from the riprap stilling basin at the low level outlet discharge, looking downstream at Prout Brook. Trees are growing along and have fallen into the stream channel.

Photo 16a – A view of the water control structure from the right side of the dam. The two gate operators are visible in the center of the structure. Also note the high brush growth on the upper right edge of the photo – this area is the upper left end of the downstream embankment.

Photo 16b – The top of the water control structure. The openings between the gate operators are covered with locked steel grates.

Photo 17 – No view of the interior of the intake structure was available.

Photo 18a – Looking upstream at the two gate operators. Although not operated on the date of inspection, both appear to be in workable condition.

Photo 18b – A close up view of the upstream gate hoisting mechanism.

Photo 18c – A photo documenting the gate serial and part numbers. This information is the same for both gate operators.

Photo 19a – An overview of the low level outlet pipe discharge and headwall.

Photo 19b – Another, closer view of the pipe outlet and headwall. The pipe is in good condition, as is the trash rack covering the opening.

Photo 19c – Looking upstream at the interior of the low level outlet pipe from its discharge end.

Photo 19d – Taken in December 2009, this photo shows the spectacle caused when debris plugging the old trash rack at the pipe discharge was cleared and flow subsequently released. The debris had frozen in place, forming an ice blockage and completely impeding flow through the low level outlet pipe. The rack had to be cut off with power saws and cutting torches, and was then replaced by the current rebar grate.

Photo 19e – A photo showing the removal of the trash rack as described in the prior caption. This was accomplished by Jay Kane of Shoreline Diving Services using a cutting torch.

Photo 20 – Crystal Lake as seen from the beach area to the left of the dam.

Photo 21a – Looking upstream from the crest of the dam toward the water control structure. The brush and vines growing near the structure and on the fencing needs to be removed. This is a perpetual problem.

Photo 21b – View of more brush growth to be removed, this time at the left abutment, and looking straight through the open gate to large-scale growth on the downstream earth embankment.

Photo 21c – An overview of the downstream embankment as seen from its toe, showing an array of vegetation – brush, vines, trees and debris – present along the slope.

Photo 21d – Deterioration along the top of the downstream concrete headwall. Another view of trees growing along the embankment is also seen in the background.

Photo 21e – A close up of the downstream headwall, showing spalling along the top of the wall.

Photo 21f – As with other areas, the downstream channel is clogged with trees, brush and debris.

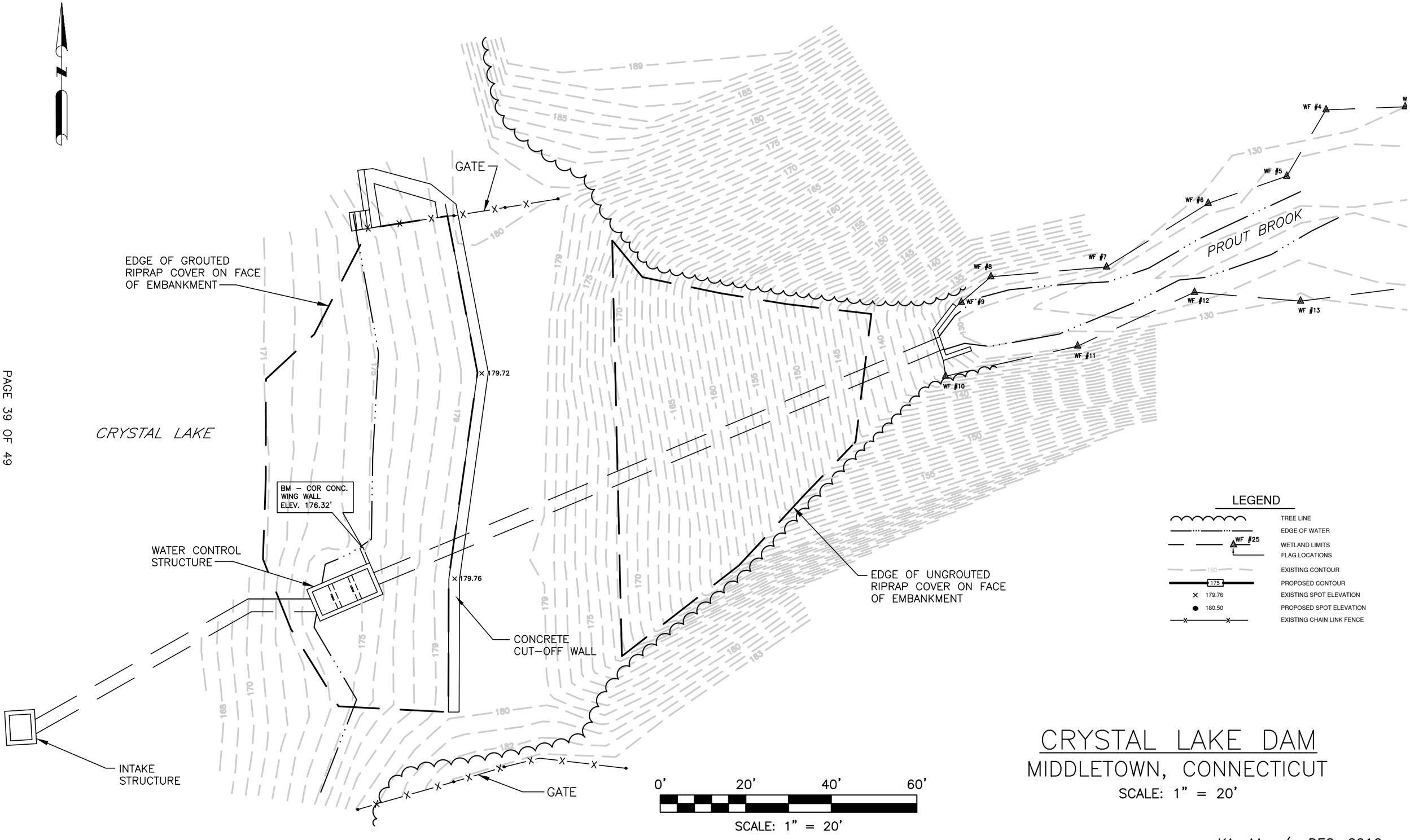
Photo 21g – A close-up view of the drop inlet spillway entrance. Several problems can be noted, included deteriorated weir boards, vegetative growth, deterioration of the concrete (exposed rebar is visible behind the diagonal piece of wood), sediment build up at the weir boards, and corrosion along the weir board channels.

Photo 21h – Looking at the interior of the intake structure. Wood boards separating the interior sections of the structure have deteriorated. On the left of the photo, the steps leading down to the base of the structure are corroding.

Part XIV: Sketches

This completed report must include a sketch of the plan view of the dam to aid in the description of its condition. Refer to the instructions for more detail and an example.

See attached site plans / sketches.

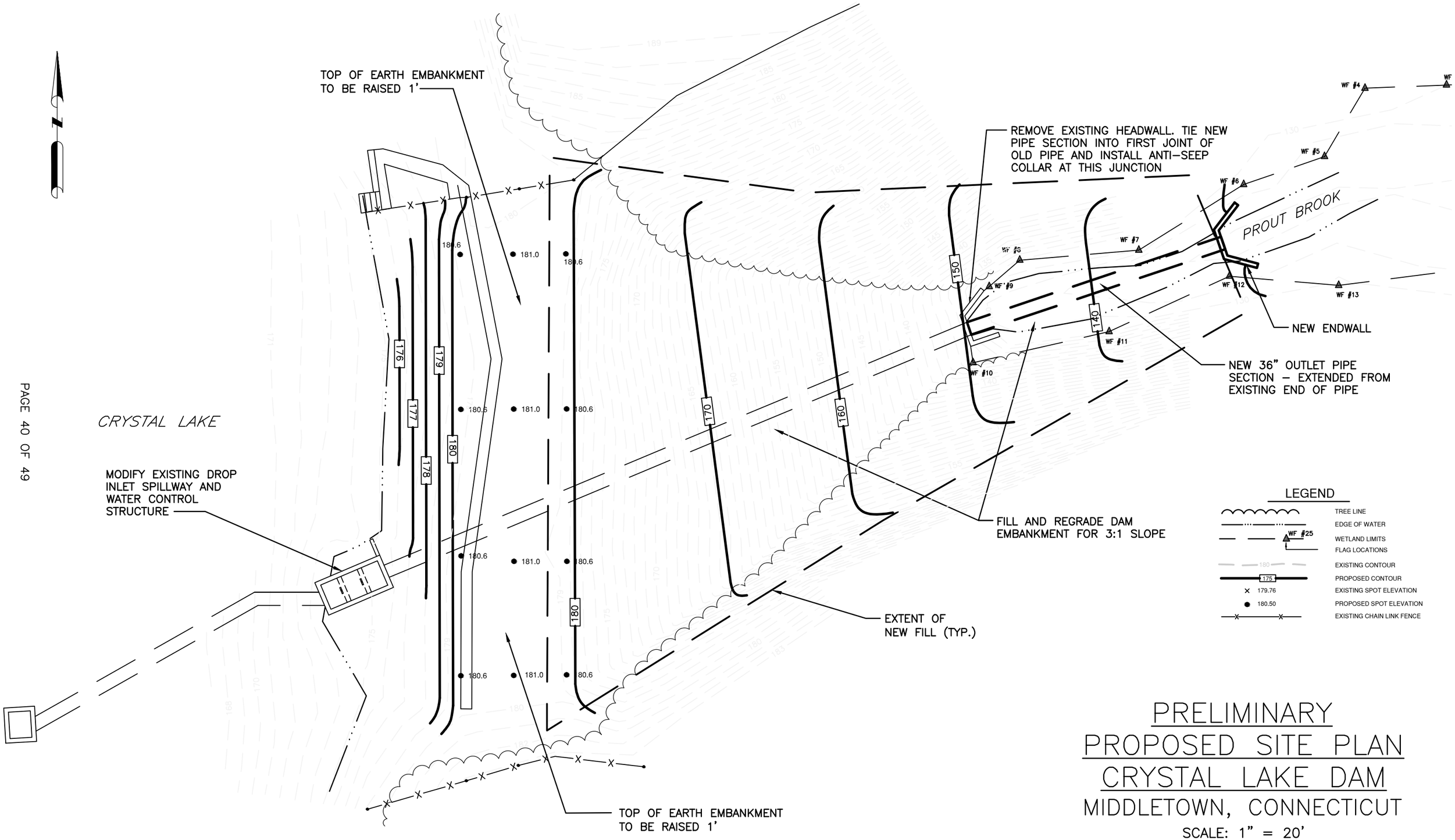


CRYSTAL LAKE DAM

MIDDLETOWN, CONNECTICUT

SCALE: 1" = 20'

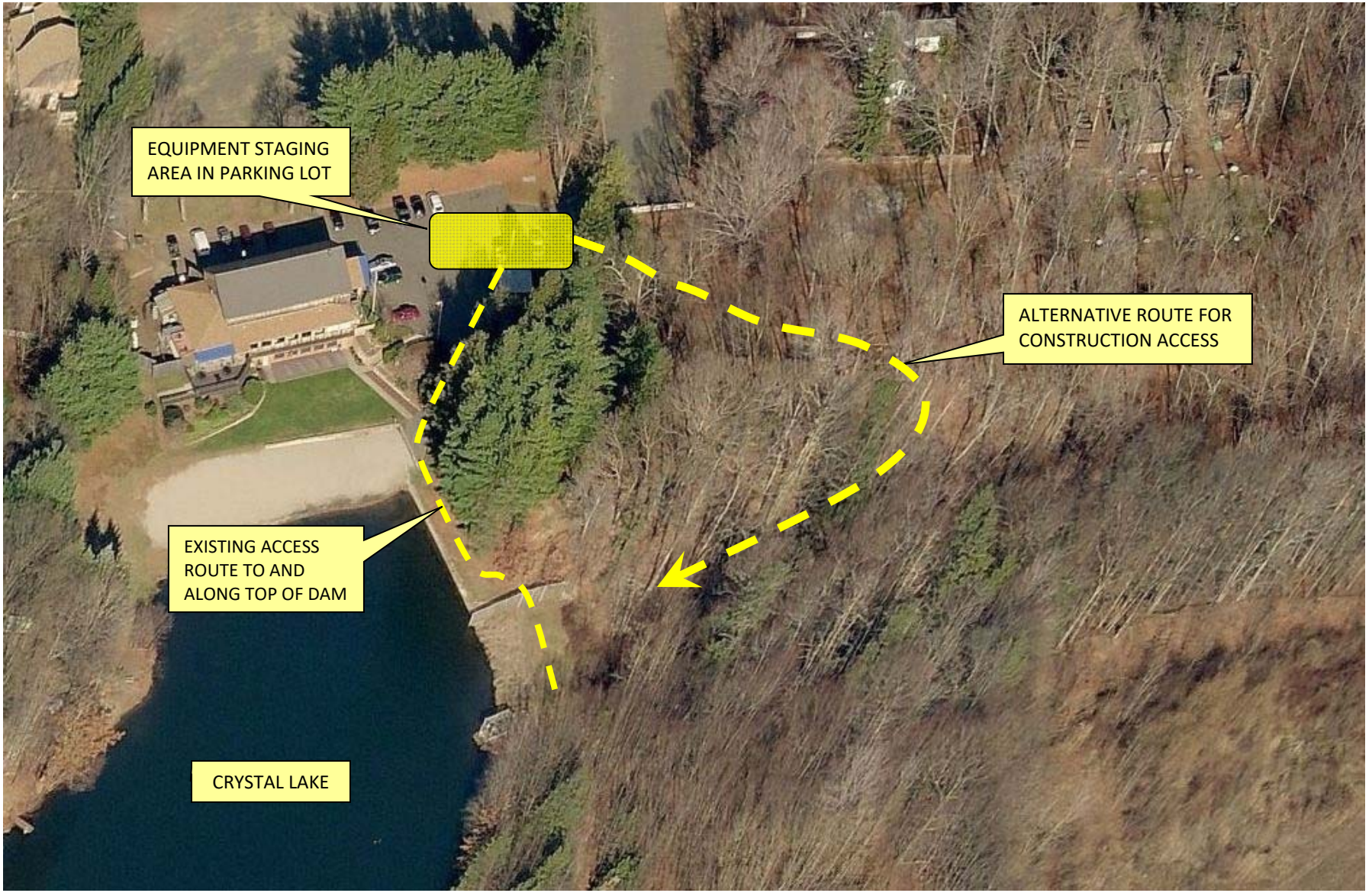
KA, AA / DEC. 2016



PRELIMINARY
PROPOSED SITE PLAN
CRYSTAL LAKE DAM
MIDDLETOWN, CONNECTICUT

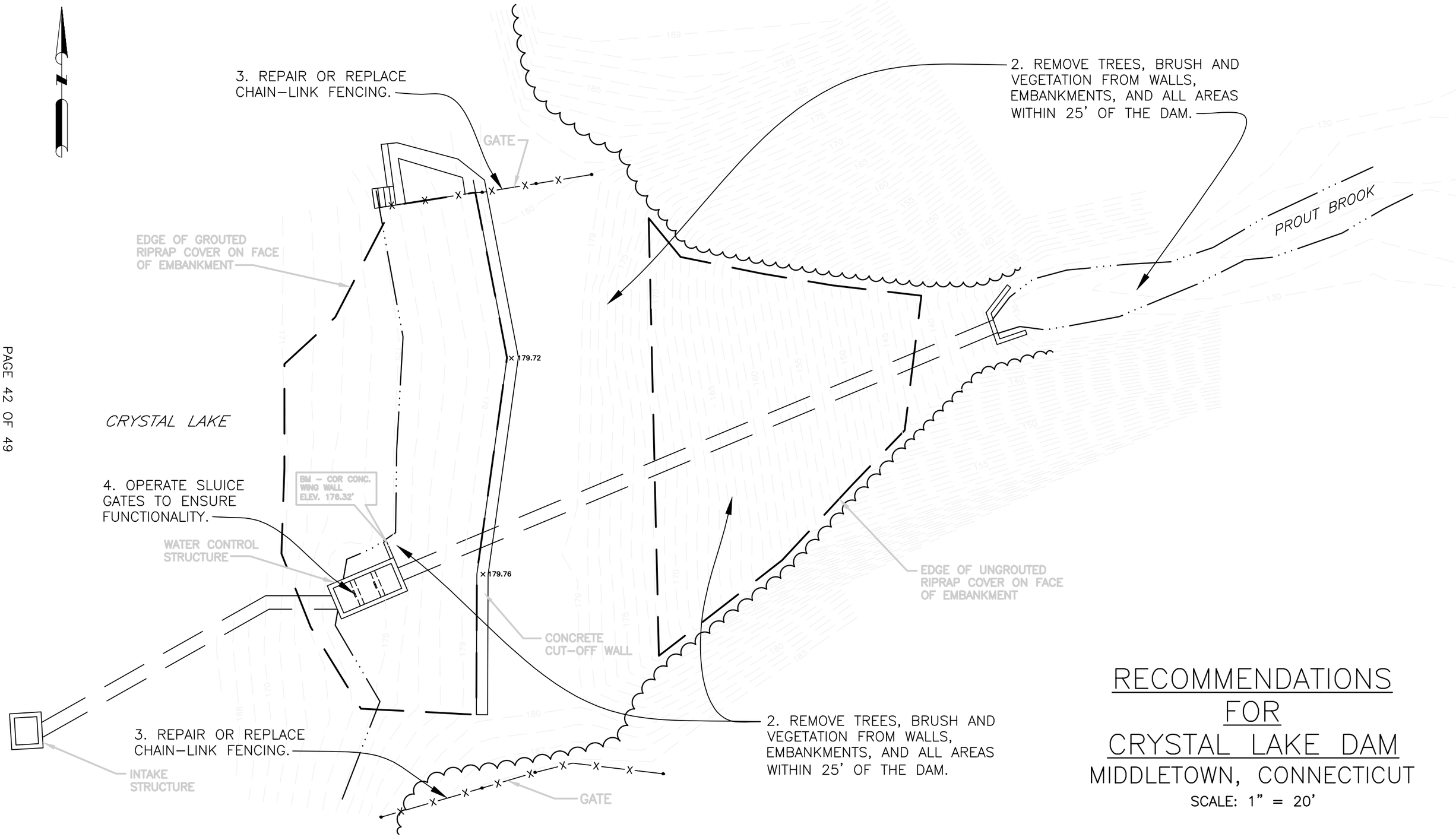
SCALE: 1" = 20'

KA, AA / DEC. 2016



CRYSTAL LAKE DAM – ACCESS, STAGING & STORAGE FOR CONSTRUCTION

NOTE: FOR RECOMMENDATIONS 1 & 5, REFER TO NARRATIVE SECTION OF REPORT.

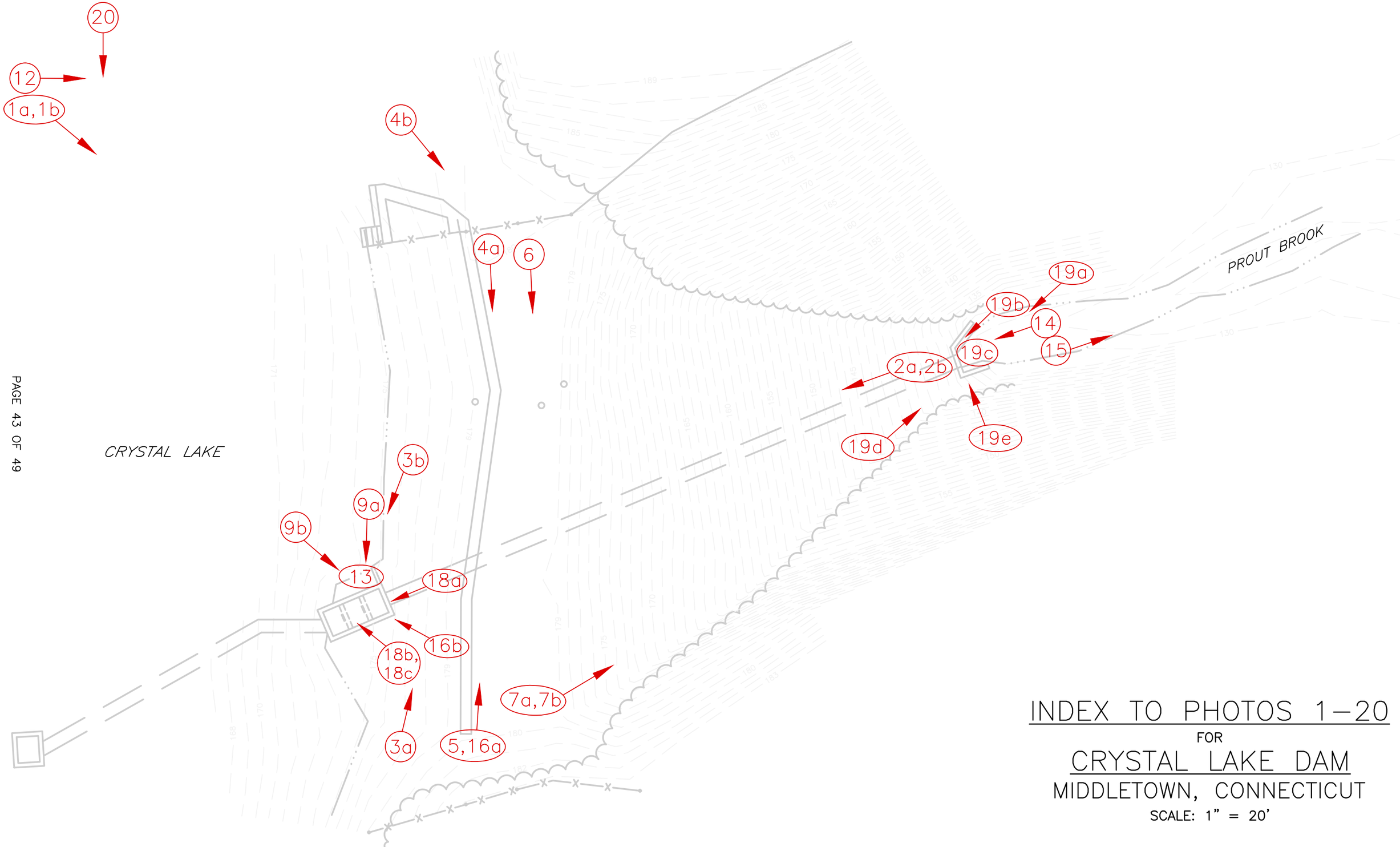


RECOMMENDATIONS FOR CRYSTAL LAKE DAM

MIDDLETOWN, CONNECTICUT

SCALE: 1" = 20'

KA, AA / DEC. 2016



INDEX TO PHOTOS 1–20

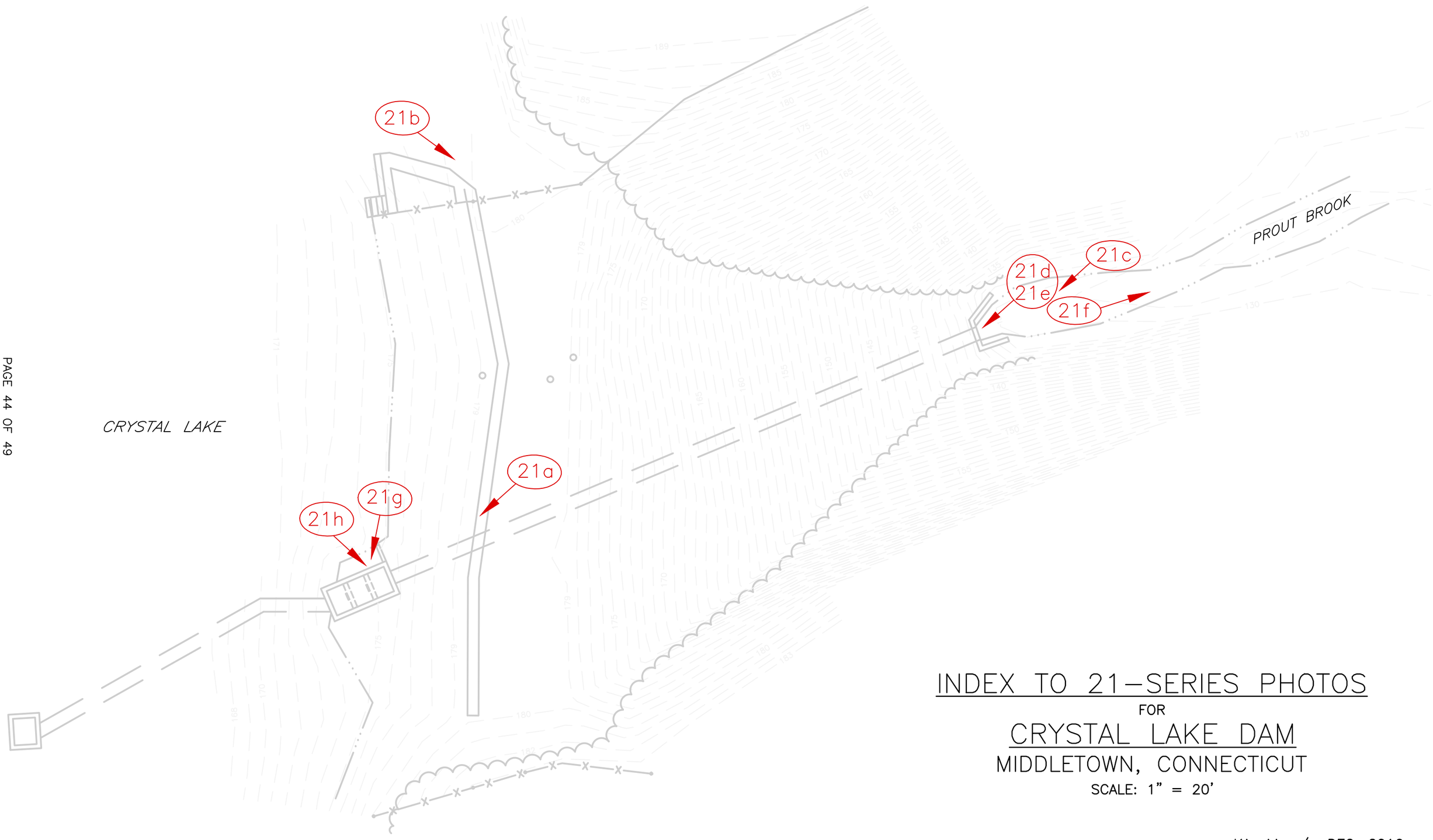
FOR

CRYSTAL LAKE DAM

MIDDLETOWN, CONNECTICUT

SCALE: 1" = 20'

KA, AA / DEC. 2016



INDEX TO 21–SERIES PHOTOS

FOR

CRYSTAL LAKE DAM

MIDDLETOWN, CONNECTICUT

SCALE: 1" = 20'

KA, AA / DEC. 2016

Part XV: Professional Engineer Certification

The following certification must be signed by a Professional Engineer

"I hereby certify that the information provided in this report has been examined by me and found to be true and correct in my professional judgment."

Karl F. Acimovic 02/15/2017

Signature of Professional Engineer Date

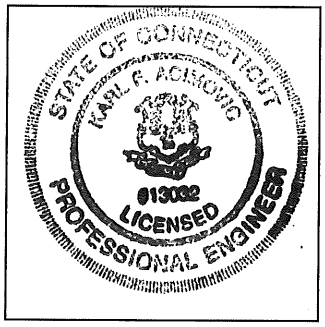
Karl F. Acimovic, P.E. **13032**

Printed Name of Professional Engineer Title CT P.E. Number

Karl F. Acimovic, P.E. & L.S., Consulting Engineer

Name of Firm

Affix P.E. Stamp Here



Part XVI: Owner Signature

The following statement must be signed by the Owner(s) of the subject Dam.

"The information provided in this report has been examined by me."	
Signature of Owner	Date
Name of Owner (print or type)	Title (if applicable)
Signature of Owner	Date
Name of Owner (print or type)	Title (if applicable)
Signature of Owner	Date
Name of Owner (print or type)	Title (if applicable)
Signature of Owner	Date
Name of Owner (print or type)	Title (if applicable)

Note: Mail the completed inspection report to:

DAM SAFETY PROGRAM
INLAND WATER RESOURCES DIVISION
CONNECTICUT DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION
79 ELM STREET
HARTFORD, CT 06106

In addition, please send this completed report converted to Adobe portable document format (pdf) including a scan of the signature page via email to: DEEP.DamSafety@ct.gov

Appendix A: Overall Dam Condition Selection Standards

Condition	Definition
Good	Through file research and after a thorough visual inspection it has been determined that the dam is well maintained and no existing dam safety deficiencies are recognized. Only continued routine maintenance is required.
Satisfactory	Through file research and after a thorough visual inspection it has been determined that no significant deficiencies are recognized. Only minor maintenance is required and only minor flaws are noted.
Fair	Through file research and after a thorough visual inspection it has been determined that there are no critical deficiencies with the dam that would require engineering analysis with the following exception: the engineer may recommend that a hydrologic and hydraulic analysis be conducted due to the lack of adequate freeboard and/or the lack of spillway capacity documentation. A condition exists at the dam that may require some sort of additional monitoring.
Poor	Through file research and after a thorough visual inspection it has been determined that deficiencies are recognized that require engineering analysis and/or remedial action.
Unsatisfactory	Through file research and after a thorough visual inspection it has been determined that a deficiency is recognized that requires immediate or emergency action. Administrative/Enforcement action may be required as determined by the Dam Safety Program. Reservoir level restrictions may be necessary until the problem is resolved.

Appendix B - Hazard Classification of Dams

I. A Class AA dam is a negligible hazard potential dam which, if it were to fail, would result in the following:

(i) no measurable damage to roadways;
(ii) no measurable damage to land and structures;
(iii) negligible economic loss.

II. A Class A dam is a low hazard potential dam which, if it were to fail, would result in any of the following:

(i) damage to agricultural land;
(ii) damage to unimproved roadways (less than 100 ADT);
(iii) minimal economic loss.

III. A Class BB dam is a moderate hazard potential dam which, if it were to fail, would result in any of the following:

(i) damage to normally unoccupied storage structures;
(ii) damage to low volume roadways (less than 500 ADT);
(iii) moderate economic loss.

IV. A Class B dam is a significant hazard potential dam which, if it were to fail, would result in any of the following:

(i) possible loss of life;
(ii) minor damage to habitable structures, residences, hospitals, convalescent homes, schools, etc;
(iii) damage to or interruption of the use of service of utilities;
(iv) damage to primary roadways (less than 1500 ADT) and railroads;
(v) significant economic loss.

V. A Class C dam is a high hazard potential dam which, if it were to fail, would result in any of the following:

(i) probable loss of life;
(ii) major damage to habitable structures, residences, hospitals, convalescent homes, schools, etc;
(iii) damage to main highways (greater than 1500 ADT);
(iv) great economic loss.

Appendix C - PHOTOGRAPH INSTRUCTIONS

All photographs shall be color photographs. Photographs shall be clear and include scale references where applicable. Photographs shall include, but not be limited to the following:

1. Overview of dam(s)/dike(s) from upstream

2. Overview of dam(s)/dike(s) from downstream

3. Overview of upstream face from right abutment

4. Overview of upstream face from left abutment

5. Overview of dam crest from right abutment

6. Overview of dam crest from left abutment

7. Overview of downstream face from right abutment

8. Overview of downstream face from left abutment

9. Overview of spillway(s) from upstream

10. Overview of spillway(s) from downstream (tailrace or channel area)

11. Overview of right training wall(s)

12. Overview of left training wall(s)

13. Overview of weir

14. Overview of stilling basin

15. Overview of downstream channel

16. Overview of gatehouse exterior

17. Overview of gatehouse interior

18. Overview of operators

19. Outlet inlets and discharge points

20. Overview of reservoir area

21. Areas of specific deficiencies (e.g., cracks, erosion, displacement, seeps, deterioration, etc.)